

Past and present challenges in flash flood forecasting
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In spite of more than 50 years of effort by the scientific, institutional and administrative sectors as well as the engineering practice to improve flood warning systems, flash floods often destroy human life and continue to stay a challenging task with regard to forecast.

First, different types of flash floods are characterised in this contribution. According to WMO-UNESCO a flash flood is defined as “a flood of short duration with a relatively high peak discharge”. The US National Weather Service has adopted a more general definition of a flash flood that follows the causative event - heavy or excessive rain, dam or levee failure - within a few hours. In Southern France, for example, a flood is considered as a flash flood, if the causative areal rainfall depth is higher than about 200 mm during less than 6 hours over natural watersheds ranging in areas from 25 to 2500 km². An urban flash flood can be produced over built-up areas of typically 1 to 100 km² by even shorter storm depths of over 50 mm in less than one hour.

Second, the development of flash flood forecast to date is outlined. Whereas the forecast, warnings and public preparedness for reducing casualties from extreme “classical” floods of medium to large river basins have improved steadily since the 1950s, the achievements for flash flood forecast have experienced less progress. One of the main reasons is the lack of (reliable) hydrometeorological records to analyse historical flash floods. Often flash floods have occurred and will occur in small natural or urban basins which are ungauged.

Heavy precipitation resulting from thunderstorms and leading to flash floods is locally concentrated. Presently, its temporal and spatial distribution cannot yet be forecasted with a high accuracy required by the hydrological and hydrodynamic models for the transformation to a hydrograph and the corresponding inundation area. Another reason is the close interaction of extreme short-term meteorological and hydrological processes under unfavourable boundary and initial conditions regarding land use, soil properties, morphology, local slope, upstream conditions which may finally lead to a disastrous flash flood. The simulation of these processes puts high demands on the quality of input data and of meteorological and hydrological modelling techniques.

In the early 1980s the WMO concluded that “flash flood forecast is one of the most difficult problems facing the hydrological and meteorological forecaster. It can be solved only by the joint efforts of the meteorologist and hydrologist because of the lack of time available and the dependence of the hydrologist on meteorological input, for example quantitative precipitation forecast”. At present these problems basically still exist, but significant progress is obtained in, for example, space-borne and ground-based remote sensing techniques for the observation of both hydro-meteorological and surface variables.

Finally, research needs for flash flood forecasting are addressed, and some relevant European activities that support research and realisation of flash flood forecasting are briefly described:

- Project KONRAD: Forecast and warning system for thunderstorms (National German Weather Service DWD)

- Flood forecast model NAXOS-PRAEDICT: adaption to flash flood forecast (Leichtweiss-Institute for Hydraulic Research, Technical University Braunschweig, Germany)
- Project PAI-OFF: process modelling and artificial intelligence for online flood forecasting in quickly responding catchments (Institute for Hydrology and Meteorology, Technical University Dresden, Germany)
- Project URBAS: Prediction and management of urban flash floods (RIMAX Research Initiative of the German Ministry of Education and Research BMBF)
- Project HYDROPTIMED: Optimisation of the hydrometeorological forecast tools (EC)
- Project NEDIES: Natural and environmental disaster information exchange: Guidelines on flash flood prevention and mitigation (EC)
- Project FLOODsite: Integrated flood risk analysis and management methodologies (EC)